Buffer Sizing Methods to Compare Critical Chain Project Management with Critical Path

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ABSTRACT

Critical Chain Project Management (CCPM) provided a tangible progress to the Project Management Body of Knowledge. The critical chain project management (CCPM) differs from the traditional Critical Path Method (CPM) which includes never changing resource dependencies. CCPM improves the project plan by aggregating uncertainty into buffers at the end of activity paths. In this research, one hundred twenty random projects were generated and analyzed using Microsoft Project software according to the traditional CPM and the CCPM once using the sum of squares (SSQ) method and another using the cut & past (C&PM) method. CCPM-SSQ method revealed an average savings of 13% and 43% in duration and cost, with a standard deviation of 21 and 11 for duration and cost respectively. While the CCPM-C&PM method revealed an average overestimation of about 2% in duration and 43% savings in cost, with a standard deviation of 25 and 11 for duration and cost respectively.

KEYWORDS

Buffer Management, Critical Chain Method, Critical Path Method, Project Management, Theory of Constraints

INTRODUCTION

Creation of reliable and accurate schedules in project management is the first step towards project success (Santiago and Magallon, 2009; Kelley, 1963). Using the Critical Path Method (CPM) implies calculating Early Start and Finish dates as well as Late Start and Finish dates by forward and backward analysis of the project network diagram paths. Choosing the relevant resources is usually done after identifying the path. Activity owners add buffers (i.e. safety margin) for each activity in order to overcome the uncertainties (Leach, 2014). Using CPM, if a resource completes an activity before the planned finish date, the time gain is still not propagated to next activity. That is because the early start date of next activity has been not reached yet. However, delays are propagated which may even change the existing critical path (Herroelen, 2001). Critical chain project management (CCPM) is the direct application of the theory of constraints to project management developed by Goldratre (1990; 1997;1998) which is a technique related to scheduling analysis for network that considers task dependencies, scarcity of resources, and buffers.
CCPM is based on methods and algorithms that are derived from the known theory of constraints. CCPM network aims at keeping the resources levelled. It also requires that they be flexible in start times. CCPM has received much attention recently in project management literature. However, there is still arguments over the advantages and difficulties of the CCPM when compared with the traditional CPM (Walker, 2015; Kasahara, 2010; Koskela 2010; Stratton, 2009; and Tukel et. al. 2006). The first buffer sizing method reduces the duration of each activity by 50% and lets the buffer size equal to the summation of half of the reduced duration for each activity. This implies about 25% reduction in project duration. Tukel et. al. (2006) referred to this as the ‘Cut and Paste Method’ (C&PM). Leach (2003) refers to this as the ‘50% of the Chain’ method, and clarifies by stating that one should not count gaps in the chain or path when applying this method. Advantages include, simple to apply method, and it provides a large enough buffer. Disadvantage of this method is not allowing to account for known variation in the feeding path. The ‘square root of the sum of squares’ method (SSQ) makes buffer size as the square root of the SSQ of the difference between low risk duration and mean duration for each task. It perhaps a duration with a probability greater than 90% of being achieved. Merit of the SSQ method is that it permits to account for known variation in task duration. Pitfall is that it could lead to undersized buffers for long chains (Leach, 2005; Tukel et. al., 2006). CCPM method’s first step is to identify the set of activities that results in critical chains. The resources which are used in the critical chain activities are usually considered as critical resources. Activities that are not included in the critical chain while at the same time converging to critical chain are considered feeders. The following step is to reduce the duration of the activity considering the buffer management. The main focus of CCPM is to eliminate the uncertain delays, task overestimation duration delays, and wasted internal buffers delays (Yang et. al., 2014). In CCPM, project duration does not change even if all the activity safety margins were eliminated, because of the project buffer (Umble, 2000). Project buffer protects the project completion on the critical chain path, while feeding buffers protects the critical chain from path merging (PMBOK, 2013). Managing the buffer further improve the decision making of project control. In general, using CCPM will further enhance the project schedule, cost, and scope performance. Experience with CCPM projects demonstrates completion with 10% to 50% in cost and duration (Leach 1999). In spite of the fact that task durations are often carefully estimated to begin with, the presence of certain behaviors causes them to increase. The traditional CPM technique faces a number of dysfunctional behaviors. These make project durations longer than necessary, which are deliberate padding, student syndrome, bad multitasking and Parkinson’s Law (Woeppel, 2005), following is a description of each:

- **Deliberate Padding** happens when after the work has been conservatively estimated several layers of management will increase it even more. Managers feel they must protect their own performance, in many organizations task estimates are not treated as “estimates” but rather as “commitments”. People do not want to be late on commitments, thus, they “pad” their estimates of how long a given task will take;
- **Student syndrome** is a natural defense mechanism in which the work is put off until the last possible moment. The student syndrome causes longer durations because some of the time needed to complete a task is lost when it is started too late or even when it is started “just in time.” Then, according to Murphy’s Law it takes even longer either due to common cause process variation or special cause process variation;
- **Bad Multitasking** occurs when an individual is working on more than one task at the same time. Multitasking is divided into two categories which are, good and bad. Good multitasking is
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